U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 97.

Experiment Station Work,

X.

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CONSTRUCTION AND COOLING OF CHEESE-CURING ROOMS.
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., May 5, 1899.

SIR: The tenth number of Experiment Station Work, prepared under my direction, is transmitted herewith with the recommendation that it be published as a Farmers' Bulletin.

Respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ILLUSTRATIONS.

EXPERIMENT STATION WORK—X.[1]

THE VALUE OF THE MANURE FROM COWS.

In experiments with dairy cows at the Texas Station a record was kept of the fertilizing constituents in the feeding stuffs used and in the excrement voided. The experiment was made with 18 Jersey or Holstein grade cows and extended over fifty-six days. The feeding stuffs used included corn meal, bran, oats, cotton-seed meal, cotton-seed hulls, silage, and sorghum hay. The calculated fertilizing value of the 651.6 pounds of corn meal consumed during the fifty-six days was $1.53; of the 745.6 pounds of bran, $3.85; 632.2 pounds of oats, $1.97; 5,464.2 pounds of cotton-seed meal, $54.25; 14,300.6 pounds of cotton-seed hulls, $21.59; 20,009.3 pounds of silage, $11.21; and 2,848.6 pounds of sorghum hay, $5.70, making the total value of the fertilizing constituents in the food consumed during the experiment $100.10. The total cost of the feeding stuffs used during the same time was $123.24. If all of the fertilizing constituents of the food could have been returned to the soil in the manure, the net cash outlay for the production of milk and butter in the above experiments would have been only $23.14.

Of course all the fertilizing material of the food does not pass through the alimentary canal into the excrements; some is retained to aid in the formation of flesh, bone, and milk. In the case of average milk cows this is estimated at 20 per cent. Allowing for this loss, the fertilizing value of the foods used in this experiment is still $80.08, making the net food cost $43.16. If the excrements from the cows are carefully preserved, by far the largest percentage of the fertilizing constituents can be successfully returned to the soil. Supposing, however, that only 50 per cent is returned to the farm, we still have a fertilizing value in these foods of $50.05, and then the net cash outlay for the foods consumed would only rise to $73.19. Thus, in determining the cost of milk and butter production, the fertilizing value of the food stuffs must be carefully considered. By many it is held that the fertilizing material secured to the farm through stock husbandry covers the cost of care and feeding, whether beef or milk forms the object.

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[1] This is the tenth number of a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

With the above data before us, this proposition seems fair and reasonable, and certainly points out the fact that this feature, so long neglected in our domestic economy, should receive careful attention. * * *

In farming, where the purchase of food may be necessary, the above facts should be carefully considered; for, if foods have to be bought, the farmer should secure the food best adapted to his purpose in feeding and furnishing the highest percentage of valuable fertilizing materials at the same time. By this means the fertility of the farm may be properly conserved and enlarged.

The following table, taken from a Farmers' Bulletin of this Department (No. 44), shows the variations in the fertilizing constituents in some of the more common farm products, and indicates the directions in which selections of feeding stuffs may be made:

Manurial constituents contained in one ton of various farm products.

	Nitrogen.	Phosphoric acid.	Potash.
	Pounds.	*Pounds.*	*Pounds.*
Meadow hay	20.42	8.2	26.4
Clover hay	40.16	11.2	36.6
Potatoes	7.01	3.2	11.4
Wheat bran	49.15	54.6	28.6
Linseed meal	105.12	32.2	24.8
Cotton-seed meal	135.65	53.2	29.2
Wheat	37.53	15.8	10.6
Oats	36.42	12.4	8.8
Corn	33.06	11.8	7.4
Barley	30.65	15.4	9.0
Milk	10.20	3.4	3.0

PLANTS ADAPTED TO ALKALI SOILS.

Throughout the western portion of the United States, especially where irrigation is practiced, areas of alkali soils of greater or less extent are of frequent occurrence. These soils derive their name from the fact that they are strongly impregnated with soluble salts, which effloresce or "bloom out" in the form of a powder or crust during dry weather following rains or irrigation. The basis of these salts is mainly soda, together with smaller amounts of potash and usually a little lime and magnesia. They are mixtures chiefly of sodium sulphate, sodium chlorid (common salt), and sodium carbonate in varying proportions. They often contain in addition small amounts of potassium sulphate, sodium phosphate, and sodium nitrate, substances whose fertilizing value is well known.

The California Station has found the amount of soluble salts in the alkali soils of that State to vary from less than 1 to over 12 per cent. Stated in another way, this means that the amount present may be as high as 500,000 pounds per acre. Usually, however, it ranges from 5,000 to 40,000 pounds per acre. Of the different forms of alkali, that in which sodium carbonate predominates (black alkali) "is by far the most injurious to vegetable growth and to the tilling qualities of the soil; common salt (sodium chlorid) ranks next in injuriousness; while sodium sulphate is the least injurious and may be present to the extent of half of 1 per cent or more without materially interfering with the

growth of most crops. It follows that in the reclamation of alkali lands for cultural purposes the first thing needful is a transformation of the sodium carbonate, if present, into sodium sulphate by means of gypsum (land plaster), reducing the injuriousness of the black alkali one-fourth to one-fifth." Experiments by the California Station have shown that in order to accomplish this successfully it is necessary to add to the soil from two and one-half to three times as much gypsum as there is sodium carbonate present.

While the occurrence of alkali in excess in the soil constitutes a serious menace to the successful production of most farm crops, recent investigations have shown that there are many plants of economic value which are able to tolerate a considerable amount of alkali. The experiment stations of California and other Western States have devoted considerable attention to the subject of the utilization of alkali soils, studying especially the relation of native and cultivated plants to alkali. The investigations of the California Station have shown that the resistance to alkali varies greatly with the kind of plant and the character of the salts in the alkali.

Thus, the plants of the goosefoot family, comprehending, besides the goosefoot proper, the beet, spinach, samphire, saltwort, and the saltbushes generally, will resist very large amounts of all three of the salts; while, on the other extreme, the legumes—clovers, peas, beans, vetches, etc.—resent even small amounts of either. The entire sunflower family is rather tolerant of alkali, while most of the cultivated grasses proper are quite sensitive, if only because their shallow rooting exposes them peculiarly to the evil effects of the surface accumulation of alkali by evaporation.

Nearly 200 species of plants native to California which will grow only on alkali soils have been studied. It appears that many of these are restricted to soils in which a certain salt predominates, and in such soils these plants often grow almost to the exclusion of other species, thus furnishing a means of judging of the kind of soil underlying them as well as of its reclaimability and adaptations. As a result of the studies along this line by the California Station, the alkali soils of California have been divided into distinct belts, or zones, each characterized by a single species of plant. The different belts, together with the amount of the various alkali salts found by analysis of the soils, are shown in the accompanying table:

Pounds of alkali salts per acre in one foot of soil from the different belts.

Belt.	Sulphates.		Carbonates.		Chlorids.		Total salts.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Scrub saltbush (*Atriplex polycarpa*)	Trace.	37,880	240	19,000	None.	21,360	840	78,240
Bushy golden-rod (*Bigelovia veneta*)	680	15,360	None.	7,480	None.	3,720	1,800	24,320
Saltwort (*Suæda* sp.)	36,000	176,000	360	24,240	26,000	105,800	74,480	306,040
Fine-top salt-grass (*Sporobolus airoides*)	3,440	98,920	680	13,480	360	55,680	6,600	155,280
Greasewood (*Allenrolfea occidentalis*)	7,440	146,000	160	3,400	10,400	85,880	27,320	194,760
Samphire (*Salicornia* sp.)	55,320	176,000	320	24,240	5,560	105,800	61,240	306,040

ceeded certain limits, germination was interfered with. The amounts of the different salts which may be present without interfering with the germination of wheat and rye were found to be as follows:

Amounts of different salts which may be present without retarding germination of wheat and rye.

	Magnesium sulphate.		Sodium sulphate.		Sodium chlorid.		Sodium carbonate.	
	In solution.	In soil.	In solution.	In soil.	In solution.	In soil.	In solution.	In soil.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Wheat	1.0	0.25	0.7	0.17	0.4	0.1	0.4	0.10
Rye	1.0	.25	.7	.17	.4	.1	.1	.02

It did not appear that any of the salts, except sodium carbonate, exerted directly poisonous or corrosive effects on the seeds. The injury appeared to be due to the fact that the salts in solution interfered with the absorption by the seed of the water necessary for germination.

The experience of the Wyoming Station indicates that there are "very few useful plants which will grow where the soil contains so much alkali that an incrustation is formed on the surface."

Incrustation of ordinary white alkali on the surface is usually marked, at least during dry weather, where there is as much as 1½ or 2 per cent of salts in the first 2 inches of soil. Such an amount of salts will prevent the growth of any of the cereals or of alfalfa. Barley and rye seem to stand more alkali than wheat or oats. Barley, rye, or alfalfa will probably grow in the presence of as much as 1 per cent of ordinary white alkali (sulphates of soda and magnesia) in 2 inches of surface soil, providing the water level is not nearer the surface than 2 or 3 feet. Usually where there is so much alkali as this, which has accumulated from irrigation above, the water comes near the surface, leaving the soil saturated most of the time. Where this occurs less than 0.5 per cent of salt along with the water is fatal to such crops. Upon soils containing about 2 per cent of salts in the first 2 inches we have tried, without success, rye, wheat, barley, oats, alfalfa, and Russian sunflowers. Brome grass and redtop have been partially successful.

Among other alkali-resisting plants which the station has successfully tested are saltbushes (*Atriplex* spp.), English rape, Bokhara or white sweet clover, and sugar beets.

THE FEEDING VALUE OF THE CORN PLANT AT DIFFERENT STAGES OF GROWTH.

On the greater number of farms, especially in those sections of the country where large acreages are cultivated by individual farmers, the corn crop is grown mainly for the grain. The ears are husked and cribbed, while the stalks are left in the field. During the winter the cattle usually feed on the stalks, and what is not eaten by them is left to decay on the ground. This method of feeding is practiced mainly because the stalks are plentiful and are fed with the least trouble in this way, and the food value of the plant after the ear has been removed is considered insignificant. On many farms, especially where farming

Both Bigelovia and scrub saltbush indicate, as far as the data at present at hand permit us to determine, a light, gravelly soil, with comparatively low alkali contents, chiefly composed of sulphates. The minimum of sulphates is lowest and the maximum highest in the scrub saltbush belt, but carbonates ("black alkali") and chlorids are lowest in the Bigelovia belt.

Samphire indicates moist soil, with excessive chlorids (common salt) and sulphates.

Greasewood (Allenrolfea) grows only, as far as our data show, in moist soil, where sulphates and common salt are heavy and carbonates light.

Saltwort (Suæda) depends on heavy chlorids and heavier sulphates, with carbonates varying between 360 and 24,000 pounds to the acre. It evidently tolerates the latter considerably, without preferring them.

Much work has yet to be done before we can determine the full extent of the value of these and other plants as alkali indicators.

Of these belts, only the first two seem favorable to reclamation, although the others will grow plants well adapted to grazing. Fine-top salt-grass is readily eaten by cattle, and the recently introduced Australian saltbushes seem quite promising for soils containing large quantities of alkali. The following preliminary list of plants suitable for cultivation on alkali soils is given:

On strong alkali.—Saltbushes (*Atriplex* spp.), fodder plants; Modiola (*Modiola decumbens*), fodder; wild millet (*Beckmannia erucæformis*), fodder; *Kolreuteria paniculata*, shrub; sac-saoul (*Haloxylon ammodendron*), dwarf timber, valued for fuel; *Salsola soda* and *S. indica*, formerly burned for barilla, used in the manufacture of glass and soap; Kochia (*Kochia* spp.), fodder plants.

Apparently not tolerant of the strongest alkali.—Vegetables—Sunflower (*Helianthus annuus*), used for chicken feed, oil, paper, and fuel; valuable for hogs; beets (garden and sugar), spinach, onion, celery, and asparagus; fruits—*Elæagnus angustifolius*, a tree with small and agreeable fruit, and Peruvian ground-cherry (*Physalis peruviana*), Jerusalem artichoke (*Helianthus tuberosus*), especially the white variety, herb, with an edible fruit; and fodder plants—slender grass (*Leptochloa imbricata*), Johnson grass (*Andropogon halepense*), quack grass (*Agropyron repens*), switch grass (*Panicum virgatum*), smooth bunch grass (*Poa lævigata*), wild rye (*Elymus condensatus*), alkali saccatone (*Panicum bulbosum*), redtop (*Agrostis alba*), Bermuda grass (*Cynodon dactylon*), jointed barley grass (*Hordeum nodosum*), tea tree (*Leptospermum lanigerum*), an Australian shrub, and Myall (*Acacia pendula* and *A. homalophylla*), shrubby acacias.

INFLUENCE OF ALKALI ON THE GERMINATION AND GROWTH OF PLANTS.

In experiments by the Wyoming Station on the influence of alkali salts on the germination of wheat and rye, it was found that small amounts of these salts hasten germination and no doubt also "assist in the life of the plant, either stimulating its growth or acting directly as plant food." When, however, the proportion of alkali salts ex-

smaller proportion in the stalks, and still less in the ears. A week later, when the plant had reached what is commonly known as the roasting-ear stage, the leaves still contained more than one-third of the dry matter, but only about one-fourth of it was found in the stalks, while the ears now contained a little over 40 per cent. This is regarded as evidence that the ears grew partially at the expense of the stalk. At the glazing period the leaves contained less than one third of the total dry matter of the crop, the stalks about one-fourth, and the ears over 44 per cent; but when the corn was fully ripe and ready to be harvested there was still over 53 per cent of the dry matter in the stalks and leaves and but 46.32 per cent in the ears.

A further study was made of the distribution of the protein and albuminoids (nitrogenous constituents, see p. 30) and the nitrogen-free extract (containing especially the carbohydrates, starches, sugars, etc., see p. 31). The results obtained in this investigation are given in the following table:

Distribution of protein, albuminoids, and nitrogen-free extract in the leaves, stalks, and ears of the corn plant at different stages of growth.

Time of cutting.	Protein.			Albuminoids.			Nitrogen-free extract.		
	Leaves.	Stalks.	Ears.	Leaves.	Stalks.	Ears.	Leaves.	Stalks.	Ears.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
August 24 (in milk)	52.70	16.00	31.30	52.50	10.00	37.50	38.50	17.50	44.00
August 31	44.69	10.96	44.35	51.06	2.53	46.41	28.40	23.64	47.96
September 7 (glazing)	40.62	9.38	50.00	42.71	5.19	52.10	29.50	25.30	54.20
September 15 (ripe)	32.30	17.10	50.60	30.60	10.70	58.70	15.90	29.40	54.70

The results show that in the earlier stages the greater portion of the protein, which is the most valuable single nutrient, was located in the leaves, and even when the corn had sufficiently matured for cutting only a little over half of it was found in the ears. About 60 per cent of the albuminoids, the most valuable part of the protein, and over half of the nitrogen-free extract (carbohydrates, starch, sugar, etc.) were found in the ears at the time of the last analysis. When the corn was fully ripe, about twice as much starch and sugar was found in the stalks as in the leaves.

In 1897 the work was partially repeated and the results were analogous to those obtained the year before. This season there was apparently a slight loss in the total dry matter between September 6 and September 15, but at the same time there was a gain of dry matter in the ears and a corresponding loss in the leaves and stalks.

During 1896 investigations were also made on the distribution of the food materials in sweet corn and sorghum. It was found that the ears of sweet corn when the plant is fully ripe contain but little more than one-half of the total dry matter, the leaves over one-fourth, and the stalks less than one-fifth. In this case, as in the case of the dent corn, the leaves included the husks. When the corn was ripe the leaves contained 23.80 per cent of the protein and 36.60 per cent of the albu-

is carried on somewhat intensively, the corn crop is cut for fodder or made into silage. When the dry season has caused a scarcity of hay corn fodder makes a most excellent substitute. The feeding value of the fodder is appreciated by many farmers, and circumstances, such as a scarcity of feeding stuffs, may force others to cut their corn and put it up as fodder in order to feed it in an economical way. The greatest difficulty in securing corn fodder is the amount of labor and time required to cut and shock it; but the corn harvester, which has come into use during recent years, has lightened this burden to a great extent and the main work now is in building the shock. The greater rapidity with which the work can now be done makes it possible to cut larger fields at the proper time.

In this connection the composition of the leaves and the stalks as the plant approaches maturity becomes a significant factor. The food value of the fodder depends largely upon the time of cutting, and after that upon the curing and storing. A study of the distribution of food material in the leaves, stalks, and ears at different stages of growth was begun by the Michigan Experiment Station in 1896 and partially repeated in 1897. The results of this investigation have been published in a recent bulletin in connection with other data.

The first year of the experiment 100 representative stalks were selected at each of four different dates, namely, August 24, when the corn was in the milk; August 31; September 7, when the corn was glazing, and September 14, when it was ripe. The weight of the leaves, stalks, and ears, and the percentage of the total weight each represented were determined as given below:

Weight of the leaves, stalks, and ears of 100 corn plants and the percentage of the total dry matter contained in these parts at different stages of growth.

Time of cutting.	Weight.				Percentage of total weight.			Percentage of total dry matter.		
	Entire plant.	Leaves.	Stalks.	Ears.	Leaves.	Stalks.	Ears.	Leaves.	Stalks.	Ears.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
August 24 (in milk)	201.75	85.0	67.75	49.00	42.13	33.57	24.30	36.41	34.27	29.32
August 31	195.00	76.0	66.50	52.50	38.98	34.10	26.92	33.63	25.52	40.85
September 7 (glazing)	210.25	82.0	69.50	59.75	39.00	33.66	27.34	30.03	25.53	44.44
September 14 (ripe)	176.50	49.5	64.00	63.00	28.04	36.26	35.70	21.77	31.91	46.32

From a feeding point of view the total weight of the plant is of less importance than the amount of dry matter contained in the plant. As is shown by the figures in the above table, the relation of the weight of the stalk to the entire plant remained very nearly constant, while the relative weight of the ear increased and that of the leaf decreased. When the plant was fully matured less than one-half of the total dry matter was in the ear, about one-third in the stalk, and more than one-fifth in the leaves. When the corn was in the milk a little over one-third of the food material was contained in the leaves, a slightly

minoids. The ears contained over 60 per cent of the total protein and were also found to be rich in the carbohydrates—starch, sugar, etc.—but not relatively so rich in these constituents as in protein.

In the study of sorghum the greater portion of the dry matter of the plant was found in the stalks, and when the plant was ripe the amount of dry matter in the leaves was about equal to the amount contained in the tops. Although over 65 per cent of the total dry matter was found in the stalks, 45.56 per cent of the protein was found in the leaves and less than 20 per cent in the stalks. The albuminoids were found to be distributed as follows: 39.33 per cent in the leaves, 36.38 per cent in the tops, and 24.29 per cent in the stalks. Nearly three-fourths of the carbohydrates—starch, sugar, etc.—was found in the stalks. The analyses show that the leaves and heads of sorghum are relatively rich in protein.

In connection with these experiments the absolute weight of dry matter and nutrients was determined in 400 hills of corn cut on different dates and from these data the yields of dry matter and nutrients per acre were calculated. The results were as follows:

Yields per acre of green fodder, dry matter, and nutrients.

Time of cutting.	Green fodder.	Dry matter.	Protein.	Nitrogen-free extract.	Fat.	Fiber.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
August 10 (tasseled)	21,203	3,670.24	472.73	1,828.15	67.90	1,010.05
August 25 (in milk)	25,493	5,320.39	576.08	3,212.45	143.11	1,148.67
September 6 (glazing)	25,865	7,110.29	711.03	4,554.14	199.08	1,294.78
September 15 (ripe)	23,007	8,020.24	696.96	5,356.72	242.61	1,413.17

The gross weight of the crop increased rapidly and regularly up to the time of glazing. After that period the change was mainly in the displacement of water by dry matter. From the tasseling of the corn to the time when the ears were in the early roasting stage there was a gain of 44 per cent in the dry matter; from the early roasting stage to the time of glazing the dry matter increased over 33 per cent, and from this stage up to maturity there was a further increase of about 12 per cent. The albuminoids and the protein increased rapidly up to the time the kernels were glazed. The increase in nitrogen-free extract and fat from the beginning of glazing to maturity was more than one-sixth and one-fifth, respectively. From these results it is concluded that in order to secure the greatest yields of dry matter and available nutrients the corn should not be harvested until fully glazed and until some of the earlier ears are nearly, if not quite, ripe.

SOWS AND PIGS AT FARROWING TIME.

The Wisconsin Station has recently published some interesting data concerning sows and pigs at farrowing time. The weight of the sows before and after farrowing was recorded, as well as the weight of the afterbirth, and the weight of each pig at birth.

The sows on which observations were made were ten in number and were pure-bred Poland-Chinas and Berkshires, crosses of these breeds, or cross-bred Poland-China-Chester Whites. They ranged in age from one to four years, and in weight from 240 to 577 pounds. The average weight before farrowing was 382.1 pounds; after farrowing, 359 pounds. The average weight of the afterbirth was 4.01 pounds. The litters averaged 16.7 pounds each. The individual pigs ranged in weight from 1.3 to 3.1 pounds, the average being 2.2 pounds. There were from 5 to 12 pigs in a litter, and in general the individual pigs in large litters were somewhat smaller than those in small litters.

In a litter of pigs there is often one much weaker than the others. This is often called the runt, or teatman. It is frequently spoken of as the last pig farrowed, this occurrence being supposed to cause inferiority. This idea was not borne out by the facts observed. The first pig born in one of the lots weighed 2.1 pounds, and the last 2.6 pounds. In other cases the pig farrowed last weighed less than the one farrowed first. In this matter, however, no regularity was observed, and it is stated that no weakness or other inferiority was observed in the last pig farrowed.

THE SOY BEAN AS A FEEDING STUFF.

The soy bean, an annual leguminous plant, has been grown from the earliest times in Japan, China, and other countries of southeastern Asia. It is said to have been introduced into this country from Japan in 1854, but for a long time it was cultivated to only a limited extent, principally in the South. In comparatively recent years, however, improved varieties, adapted to varying climatic conditions, have been introduced, and the cultivation of the plant has spread quite rapidly, its range of successful culture being almost as wide as that of corn. Many of the stations have experimented with the bean and thus called attention to its merits, and the Division of Agrostology of this Department has issued a Farmers' Bulletin (58) which discusses in detail the characteristics, varieties, and culture of the plant and its value as a food and feeding stuff.

The Japanese and other Orientals grow the plant mainly for the seed which are used in the preparation of a variety of foods. The bean is rich in nutritive material and makes a valuable food. It has a high protein content, and hence serves well to balance the diet of people, such as the Japanese, who do not eat much meat. There is no special demand for such a food in this country, however, and so the soy bean is likely to be, at least for many years to come, of most value as a feeding stuff. It serves admirably to balance the rations fed to stock. The plant may be fed as green fodder, hay, or silage; or the beans may be fed in the form of meal. As a green fodder it has been fed at several stations with varying success. It seems that stock in many cases does not relish it at first, but becomes accustomed to it.

The food constituents in the soy bean and in corn and some other feeding stuffs are shown in the following table of average analyses:

Food constituents in soy beans as compared with other feeding stuffs.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Green soy bean (whole plant)	75.1	2.6	4.0	6.7	10.6	1.0
Green corn fodder	79.3	1.2	1.8	5.0	12.2	.5
Soy-bean hay (with pods and seeds)	11.3	7.2	15.4	22.3	38.6	5.2
Dry corn fodder (with ears)	42.2	2.7	4.5	14.3	34.7	1.6
Soy-bean straw (after thrashing)	10.1	5.8	4.6	40.4	37.7	1.7
Corn stover (plant without ears)	40.5	3.4	3.8	19.7	31.5	1.1
Soy-bean seed	10.8	4.7	34.0	4.8	28.8	16.9
Corn kernels	10.9	1.5	10.5	2.1	69.6	5.4
Soy-bean meal	10.8	4.5	36.7	4.5	27.3	16.2
Pea meal	10.5	2.6	20.2	14.4	51.1	1.2
Corn meal	15.0	1.4	9.2	1.9	68.7	3.8
Cotton-seed meal	8.5	7.2	43.3	5.4	22.3	13.5
Linseed meal (new process)	10.1	5.8	33.2	9.5	38.4	3.0
Soy-bean silage	74.2	2.8	4.1	9.7	6.9	2.2
Clover silage	72.0	2.6	4.2	8.4	11.6	1.2
Corn silage	79.1	1.4	1.7	6.0	11.0	.8
Soy bean and corn silage	76.0	2.4	2.5	7.2	11.1	.8
Soy bean and millet silage	79.0	2.8	2.8	7.2	7.2	1.0

It will be readily seen from the above table that the soy bean is very rich in nutritive materials, the green plant being much richer than green-corn fodder and the ripe seed than corn kernels. In fact the composition of the seeds more closely approaches that of the oil cakes—cotton-seed meal, linseed meal, etc.—than any other class of feeding stuffs. It has been shown by the Massachusetts Station, however, that with the yields usually obtained in that section corn produces a larger amount of nutritive material per acre than the soy bean. The latter, however, has the following advantages: "(1) It can draw much of its nitrogen from the air; (2) the bean stubble and roots probably have greater manurial value than those of corn; and (3) the bean, being so rich in flesh formers [protein], may take the place of such concentrated foods as cotton-seed meal, linseed meal, gluten meal," etc. As the analyses show, the hay, like that of other leguminous plants, is rich in protein. The plant is likely to lose a large part of its leaves in the process of curing and thus suffer a serious reduction in nutritive value.

The value of this crop for silage is recognized. It is highly nutritive, gives a heavy yield, and is easily cultivated. The vigorous late varieties are well adapted for silage. The crop is frequently ensiled with corn (2 parts of the latter to 1 of the former), and like other legumes it improves the silage by tending to counteract the acid reaction of corn silage.

Soy-bean meal is a highly nutritious feeding stuff. An experiment conducted at the Massachusetts Hatch Station led to the conclusion that soy bean meal is a better feeding material for dairy cows than cotton-seed meal. The soy-bean meal produced more milk, richer cream, and better butter.

The Kansas Station has probably experimented with the soy bean

more extensively than any other station. Its experience with the soy bean as a food for stock is reported as follows:

With dairy cows soy-bean meal takes the place of linseed meal, being somewhat richer in protein, a laxative feed, and softening the butter fat. Not over 3 pounds per day should be fed to a cow, and the softening effect on the butter may be overcome by giving feeds having the opposite tendency, such as corn, Kafir corn, and cotton-seed meal.

In the winter of 1898, in fattening 7½-months-old pigs, the gains per bushel of feed were:

	Pounds.
Kafir-corn meal	11.7
Shelled corn	12.3
Kafir-corn meal four-fifths, soy-bean meal one-fifth	13.9

With pigs 6 months old the gains per bushel of feed were:

Kafir-corn meal	9.4
Shelled corn	11.2
Kafir-corn meal four-fifths, soy-bean meal one-fifth	13.2

With both lots the pigs having soy-bean meal made the most rapid growth and were ready for market much earlier.

With weaning pigs the gains per bushel of feed were:

	Pounds.
Kafir-corn meal	10.4
Corn meal	11.5
Kafir-corn meal two-thirds, soy-bean meal one-third	15.4
Corn meal two-thirds, soy-bean meal one-third	15.6

In the fall of 1898 this station bought of farmers 60 ordinary stock hogs of mixed breeds. The gains per bushel of feed in fattening these hogs were:

	Pounds.
Kafir-corn meal	7.5
Kafir-corn meal four-fifths, soy-bean meal one-fifth	12.0

The hogs fattened with soy-bean meal have just been marketed, while those not having it will not be ready for four or five weeks.

ALFALFA HAY FOR HOGS.

The Kansas Experiment Station has recently reported the results of experiments made during the fall of 1898 to test the value of alfalfa hay fed to pigs receiving all the grain they would eat.

The pigs, averaging 125 pounds each, were placed in lots of ten in large pens provided with shelter sheds open to the south. Alfalfa hay of the best quality was fed dry in a large flat trough, the pigs receiving in addition all the black-hulled white Kafir corn they would eat without waste. The animals were given more hay than they would eat and they consumed only the leaves and finer stems. Beginning November 24 and continuing nine weeks one lot of pigs was fed alfalfa hay and Kafir-corn meal dry; a second lot, Kafir corn dry; a third lot, Kafir-corn meal dry; and a fourth lot, Kafir-corn meal wet.

The gains per hog in the nine weeks from the different methods of feeding were as follows:

	Pounds.
Kafir-corn meal dry and alfalfa hay	90.9
Kafir corn whole	59.4
Kafir-corn meal fed dry	52.4
Kafir-corn meal fed wet	63.3

At the end of the experiment the alfalfa-fed pigs were well fattened and were marketed. It is estimated that under normal conditions it would have taken four or five weeks longer to put the other lots into good marketable condition.

The gain from feeding alfalfa hay with Kafir-corn meal fed dry, over the meal alone fed dry, was more than 73 per cent.

Ten hogs in nine weeks were fed 656 pounds of alfalfa hay; and for each 7.83 pounds of alfalfa hay fed with the dry Kafir-corn meal the hogs gained 3.4 pounds over those having dry Kafir-corn meal alone—a gain of 868 pounds of pork per ton of alfalfa hay. These results are not due to the feeding value of the alfalfa alone, but also to its influence in aiding the hogs to better digest the Kafir corn. The alfalfa hay also gave a variety to the ration, making it more appetizing and inducing the hogs to eat more grain. The ten hogs having grain alone ate 3,885 pounds of dry Kafir-corn meal, while the ten hogs having hay and grain ate 4,679 pounds of the Kafir-corn meal and 656 pounds of alfalfa hay. The hay-fed hogs ate more grain and gained more for each bushel eaten.

In a former experiment at this college, pigs were pastured through the summer on alfalfa with a light feeding of corn. After deducting the probable gain from the corn, the gain per acre from the alfalfa pasture was 776 pounds of pork.

These facts indicate that to produce pork most cheaply the Kansas farmer must have alfalfa pasture in summer and alfalfa hay in winter.

ANIMAL MATTER A NECESSITY FOR POULTRY.

It is well known that poultry when allowed to range at will eat considerable quantities of animal matter in the form of insects, worms, etc.

How necessary this animal matter is to the health of fowls, and especially ducks, was strikingly brought out by recent experiments at the New York State Experiment Station. Two lots each of chickens and ducks, as nearly alike as possible, were used in these experiments. One lot in each case was fed a ration of mixed grains and skim milk or curd containing no animal matter, the other a ration of mixed grains, with animal meal and fresh bones or dried blood. The two rations were about equally well balanced, although the "animal-matter" ration contained a little less protein than the "vegetable-matter" ration. The distinctive difference between the two rations was that in the one case two-fifths to one-half of the protein came from animal sources, while in the other it all came from vegetable sources.

Two trials were made with chickens.

In each trial more food was eaten by the lot receiving animal protein, the gain in weight was more rapid, maturity was reached earlier, less food was required for each pound of gain, and the cost of gain was less.

During the first twelve weeks of the first trial [starting with chickens one-half week old] the chicks on animal meal gained 56 per cent more than those on the vegetable diet, although they ate only 36 per cent more; they required half a pound less of dry matter to gain 1 pound and each pound of gain cost only $4\frac{1}{4}$ cents, as compared with $5\frac{1}{3}$ cents for the grain-fed birds.

During the next eight weeks the cost of gain was $7\frac{1}{2}$ cents and $11\frac{1}{3}$ cents, respectively. The animal-meal chicks reached 2 pounds in weight more than five weeks before the others; they reached 3 pounds more than eight weeks sooner, and three pullets of the lot began laying four weeks earlier than any among the grain-fed birds.

With the second lot of chicks, starting at six weeks of age, the differences were in the same direction, though not quite so striking, thus showing that the great advantage of the animal nitrogen is in promoting quick, healthy growth and early maturity rather than increasing the tendency to fatten. * * *

The results were most convincing, almost startling, in the case of ducklings fed the contrasted ration. * * * Before the experiment had been long under way it was noticed that the animal-meal birds were developing rapidly and evenly, but the grain-fed ducklings were becoming thin and uneven in size. It was sometimes almost pitiful to see the long necked, scrawny, grain-fed birds, with troughs full of good, apparently wholesome food before them, standing on the alert and scrambling in hot haste after the unlucky grasshopper or fly which ventured into their pen, while the contented-looking meat-fed ducks lay lazily in the sun and paid no attention to buzzing bee or crawling beetle. The 32 meat-fed birds lived and thrived, but the vegetable-food birds dropped off one by one, starved to death through lack of animal food, so that only 20 of the 33 were alive at the close of the fifteenth week of contrasted feeding. They were then fed for four weeks on the meat-meal ration and made nearly as rapid gains as the other lot at the same size two months before, but they never quite overcame the disadvantage of their bad start on grains alone. * * *

In conclusion, then, it may be said that rations in which from 40 to 50 per cent of the protein was supplied by animal food gave more economical results than rations drawing most of their protein from vegetable sources. The chief advantage was in the production of rapid growth, although the cost of production is also in its favor. While inferior palatability may have had something to do with the marked results, especially with the ducks, the whole bearing of these experiments and others not yet reported seems to indicate that the superiority of the one ration is due to the presence in it of animal food.

RELATION OF WATER SUPPLY TO ANIMAL DISEASES.

About three-fifths of the animal body is water, and while water is not strictly a food in itself, no food can be assimilated without the aid of water, large quantities of it being required to carry on this process. According to a bulletin of the Indiana Station—

The horse requires from 64 to 80 pounds, or 8 to 10 gallons per day, a gallon of water weighing 8 pounds. During the months of February and March five horses drank from 48 to 60 pounds per head when not at work, and from 62 to 84 pounds while at work. Forty-four per cent of the water was drunk in the forenoon and 56 per cent in the afternoon.

Cattle drink more than horses. During the period above referred to, cows not giving milk drank 78 pounds and cows in full flow of milk drank 112 pounds per day. The largest drink was 122 pounds and the greatest amount taken by one animal in one day was 176 pounds. The Utah Experiment Station found that steers feeding upon dry feed required 83 pounds of water per day, while those fed upon green food consumed only 33 pounds per day. Cattle drank 72 per cent of water in the morning and 28 per cent in the evening.

Pigs fed corn and skim milk (3 pounds per day) drank 2.65 pounds of water per day; those fed wheat and skim milk, 5.2 pounds; those fed corn, wheat, and skim milk, 3.9 pounds; those fed soaked wheat and skim milk, 5.3 pounds. These figures indicate, as in the experiments with steers at the Utah Station, that the amount of water drunk is influenced to a considerable extent by the character of the food.

No attempt has been made to determine the quantity of water needed daily for sheep. * * * They drink comparatively little water while upon pasture. They

can endure privation as regards water far beyond other domestic animals. This has led to the belief common among farmers that sheep do not need water and that dew is sufficient. This is a serious mistake, and accounts for the loss of many hundred lambs in this State every year.

The number of times an animal will drink during the day, when allowed full opportunity, is not known, but is indicated in a general way by the stomach. The stomach of the horse is small and, as might be supposed, does not require much water at a time, but often. The stomach in cattle is very large, and rumination (chewing the cud) is performed. This necessitates saturating the food with water before rumination can take place, and probably explains why so much water is drunk in the morning.

The above facts make it clear that we may expect a close and important relationship between water supply and disease in domestic animals, and this fact is most strikingly demonstrated when the supply is insufficient or is contaminated with matter which causes disease.

The diseases which arise as a result of supplying water in insufficient quantities or not providing water in accessible places are sporadic in character; that is, affect only an occasional animal, or a few in a herd or flock. Probably the most serious disease having such cause is mad itch in cattle. This occurs especially in the fall of the year, when the cattle are upon dry pasture or when turned in upon a dry stalk field. It may occur at other times, and also be due to other causes, but without doubt 90 per cent of the cases occurring in this State are directly traceable to this cause. Sheep also suffer from impaction and constipation, and large numbers die for want of proper water supply. Hogs, especially young ones, often succumb from like treatment. Horses probably suffer least loss, because they receive the greatest care in this respect, but no doubt many cases of colic, impaction, and constipation are traceable to this source.

The losses that arise from an insufficient water supply are small compared with those caused by water of an improper character. Water which comes from deep wells, properly protected, is free from disease germs; that, however, which comes from ponds, ditches, and streams may contain such germs. "Not all surface waters are dangerous, but all are more or less exposed to infection, and may become dangerous at any time."

Careful investigation has shown that hog cholera has been largely disseminated in Indiana by contaminated streams, thus bearing out the conclusions from investigations by the Bureau of Animal Industry of this Department that "perhaps the most potent agents in the distribution of hog cholera are streams. * * * The first step to be taken in the prevention of hog cholera is the securing of a wholesome water supply."

There are numerous parasitic diseases to which all animals are subject. Water is necessary to the growth of these and is an important carrier of them. Such parasitic diseases as twisted stomach worms, nodular disease, paper skin, liver fluke, and lung worm of sheep, and worms in hogs, horses, and cattle, are largely due to surface water. "Pure water from deep wells is the preventive."

COOLING OF CHEESE-CURING ROOMS.

The importance of properly constructed cheese-curing rooms, with provision for regulating the temperature, was emphasized in the report of the Wisconsin Experiment Station for 1897, and a more recent bulletin of the station gives practical recommendations on this point:

The watchful eye of the maker is too often diverted from the cheese as soon as it is placed upon the shelves. Inspection of the conditions under which cheese is cured in this country almost without exception shows that the details of the curing process receive little or no attention. Curing rooms are built in the cheapest possible manner. No attempt is made to control the temperature or the moisture content of the same. It is not at all uncommon to find cheese stored in places the temperature of which is subject to almost as much fluctuation as the outside air.

The result is not only a temperature far too high for proper cheese ripening, but sudden fluctuations in the temperature, which are extremely undesirable. The effect of the high temperatures is very deleterious to the quality of cheese, resulting in the melting and leaking out of the fat and a serious injury to the texture and flavor of the cheese. This was demonstrated by the station in a series of experiments, in which cheese was cured under conditions which ordinarily prevail at cheese factories in the State, and also in rooms where the temperature was carefully controlled. The cheese cured at a high temperature "had a rank flavor and a value not exceeding 3 or 4 cents a pound," whereas the cheese cured at 55° F. and below was invariably of good quality and entirely free from all bitter flavor, and was rated by an expert at 7¾ cents. The limit to the safety zone is said to be about 65° F., and a temperature of from 65° to 75° is regarded as hazardous, while a temperature above 75 degrees is regarded as invariably detrimental.

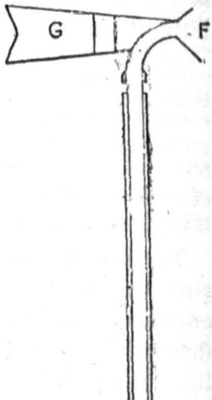
No matter how carefully an above-ground curing room has been constructed, if the temperature is to be held below 65° it must be artificially cooled by some method. This may be effected by (1) ventilating with night air, (2) ventilating through horizontal subearth ducts, (3) ventilating through deep vertical subearth ducts and wells, (4) the use of cold water, (5) ventilating over ice, (6) evaporation of water, and (7) mechanical refrigeration. The bulletin considers only the first three methods.

COOLING BY VENTILATING WITH NIGHT AIR.

Where rooms are cooled by ventilating with night air, some means must be adopted for forcing the air into and out of the rooms. The simplest means is the use of a 10-inch galvanized-iron flue, rising from the curing room not less than 15 feet above the ridge of the roof of the factory and terminating in a wind funnel. While night ventilation is an improvement over no effort to control the temperature, it is not believed that it will give the best results.

COOLING BY VENTILATING THROUGH HORIZONTAL SUBEARTH DUCTS.

Professor King, of the station, has given considerable study to cooling by means of subearth ducts, and as a result of his work several factories in Wisconsin have been equipped with such arrangements. These ducts may be horizontal or vertical. An illustration of a horizontal duct is given in fig. 1. The horizontal subearth duct to be most effective should not be less than 12 feet below the surface and have a length of at least 100 feet. The duct may be a single flue made of cement tile, or a multiple duct made of a series of drain tiles laid in tiers. The multiple duct cools the air more effectually, as it presents the larger cooling surface, but the air does not pass through it as fast as through the single duct, especially when the wind is light. Accordingly, on days



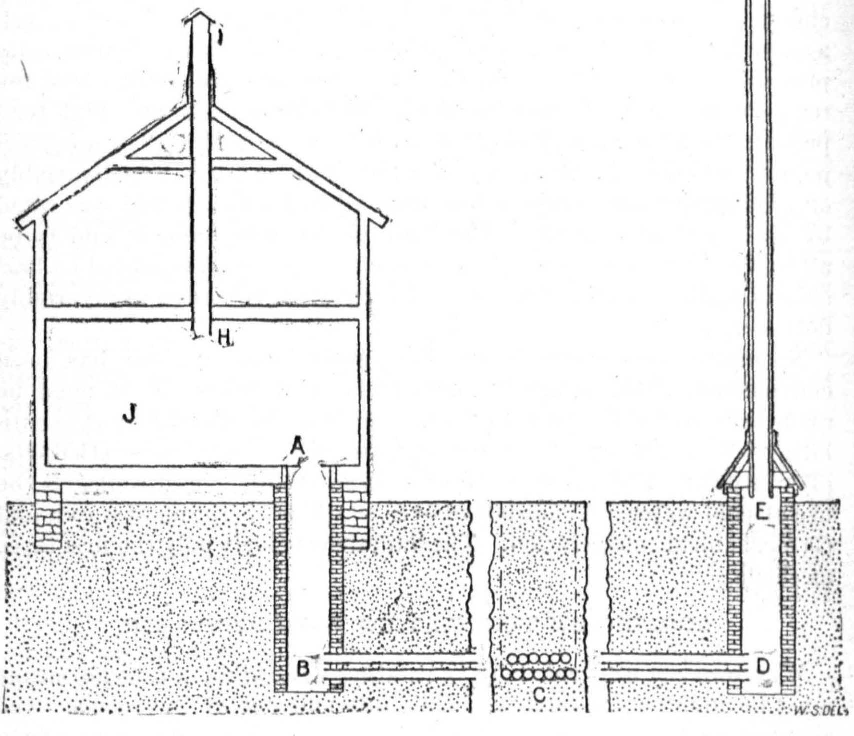


FIG. 1.—Section of cheese-curing room and horizontal multiple subearth duct: A, inlet to curing room; B, end of subearth duct in bricked entrance to factory; C, cross section of the multiple ducts; D, E, bricked entrance under funnel at outer end of subearth duct; F, funnel with mouth 36 inches across; G, vane to hold funnel to the wind.

when the wind is light the multiple duct may not be as effective as the single duct of the same total cross section and length. Professor

King recommends either three rows of 10-inch tile or five rows of 8-inch tile. The cost would be about the same in both cases. The tile may be placed side by side, or the trench may be dug narrower and a foot or two deeper and the tile placed one above the other. The flue for conducting the air from the funnel to the duct may be made of plank with the inside opening 12 inches square, or of galvanized iron with a diameter of 12 inches. The latter is considered preferable, as it is not so likely to leak air. Fifty feet in height is considered sufficient for this flue unless there are obstructions to the wind. The construction of the funnel is shown in fig. 2.

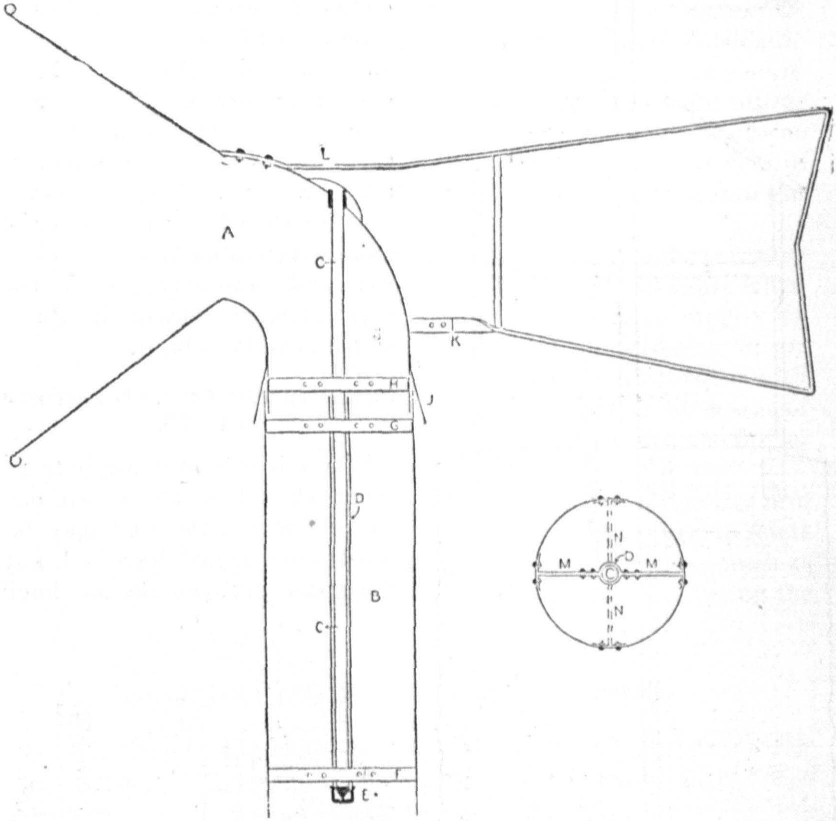
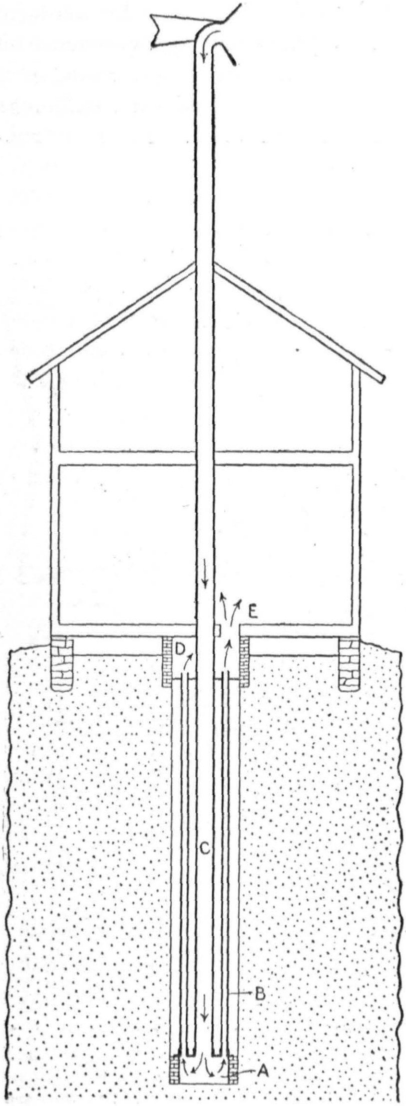


FIG. 2.—Showing how funnel and vane may be mounted: A, funnel; B, shaft of funnel; C, C, C, 1-inch gas pipe; D, D, $1\frac{1}{4}$-inch gas pipe; E, cap for support of 1-inch gas pipe; F, G, H, and M M and N N are stays of band iron bolted together and to the sides of the shaft to support the axis of the funnel; J, weather collar to turn rain out of shaft; K, L, band iron to stiffen vane and attach it to funnel.

COOLING BY VENTILATING THROUGH DEEP VERTICAL SUB-EARTH DUCTS.

If it is possible to go down some distance before striking water, vertical ducts may be successfully used. These require less piping, which will reduce the friction and hence give a greater current in lighter

winds than in the case of long horizontal ducts. It is recommended to make the vertical duct not less than 25 or 30 feet in depth if practicable. Its construction is shown in fig. 3. An ordinary well is dug about 40 inches in diameter, with the large inlet pipe in the center and surrounded by thirteen lines of 6-inch drain tile or 5-inch galvanized iron pipe, the earth being closely packed between the different lines of pipe. The upper end of this system of pipes leads into a chamber which communicates directly with the curing room. In practical experience in a cheese factory in Wisconsin a well 64 feet deep used as a subearth duct was found to be quite efficient. Professor King believes that the closed well will be found more serviceable than the open well, and more effective than the much longer horizontal ducts which have been built.



COOLING THE SOIL FOR SHORT DUCTS.

Where it is impracticable to go deeper than 15 or 20 feet without striking water, the well may be constructed as just described, and the space between the air flues

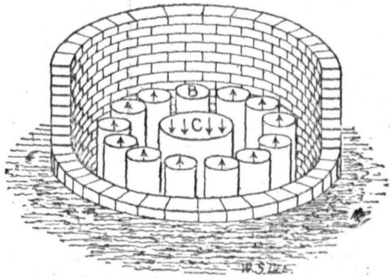


FIG. 3.—Showing vertical subearth duct: A, brick chamber 25 to 30 feet below surface and 40 inches inside diameter; B, tile or conductor pipe of galvanized iron; C, main shaft of funnel; D, brick chamber at upper end of duct.

filled in with sandy soil or fine sand and this cooled by pumping cold water from the well upon it once a week or oftener. Where this is done, galvanized iron flues are preferable to drain tile, which will allow

water to percolate into them. The bottom of the duct should be at least 4 feet above standing water in the ground, so as to give good drainage.

COOLING WITH AIR FORCED THROUGH COLD WATER.

Where the ground water is so close to the surface that a vertical duct could not be made more than 12 or 15 feet deep, a cistern about 5 or 6 feet in diameter may be constructed and the air cooled by passing it through a system of pipes in the cistern, as shown in fig. 4. The flue for introducing the air runs down to the bottom of the cistern, where it connects with an air-tight drum, into which are soldered 13 or more 5-inch flues of galvanized iron, 10 feet long, which communicate with a second drum at the surface of the cistern. The air passes down through the center flue, is distributed to the 13 or more pipes, which are surrounded by water, and rises to the upper drum, from which it is led into the curing room. The water in the cistern can be changed from time to time if it is found that the air is coming into the curing room too warm.

Whatever form of duct is used, it is necessary to control the entrance of the air into the curing room by means of a damper, because when the wind is strong the air may pass through the duct so rapidly as not to be properly cooled. If it is found that the air is coming in too warm the current should be partly shut off. In factories provided with an engine the air may be blown through the cold-air duct by means of a small blower. The blower could be used at times when the funnel did not work.

From observations which Professor King has made in factories provided with these means of cooling, it appears that with subearth ducts the temperature of the curing rooms may be held at least as much as 7° to 10° F. lower than the temperature of the outside air during the hottest portion of the day.

CONSTRUCTION OF CHEESE-CURING ROOMS.

The efficiency of the methods described above for cooling cheese-curing rooms in summer depends very much upon the thoroughness of the construction of the rooms, by which the outside air is excluded. If anything like the full effectiveness of the subearth duct is to be obtained, two important points must be secured: (1) The walls must be so tight that the pressure and suction of the wind on the building do not drive out the cool air and leave in its place the warm air of the outside, and (2) the walls must be sufficiently poor conductors to permit a relatively small amount of air from the subearth duct to remove all of the heat which penetrates the walls. If the walls permit any air to pass through, then to that extent will the air coming through the duct be decreased. The object sought in the construction of the perfect

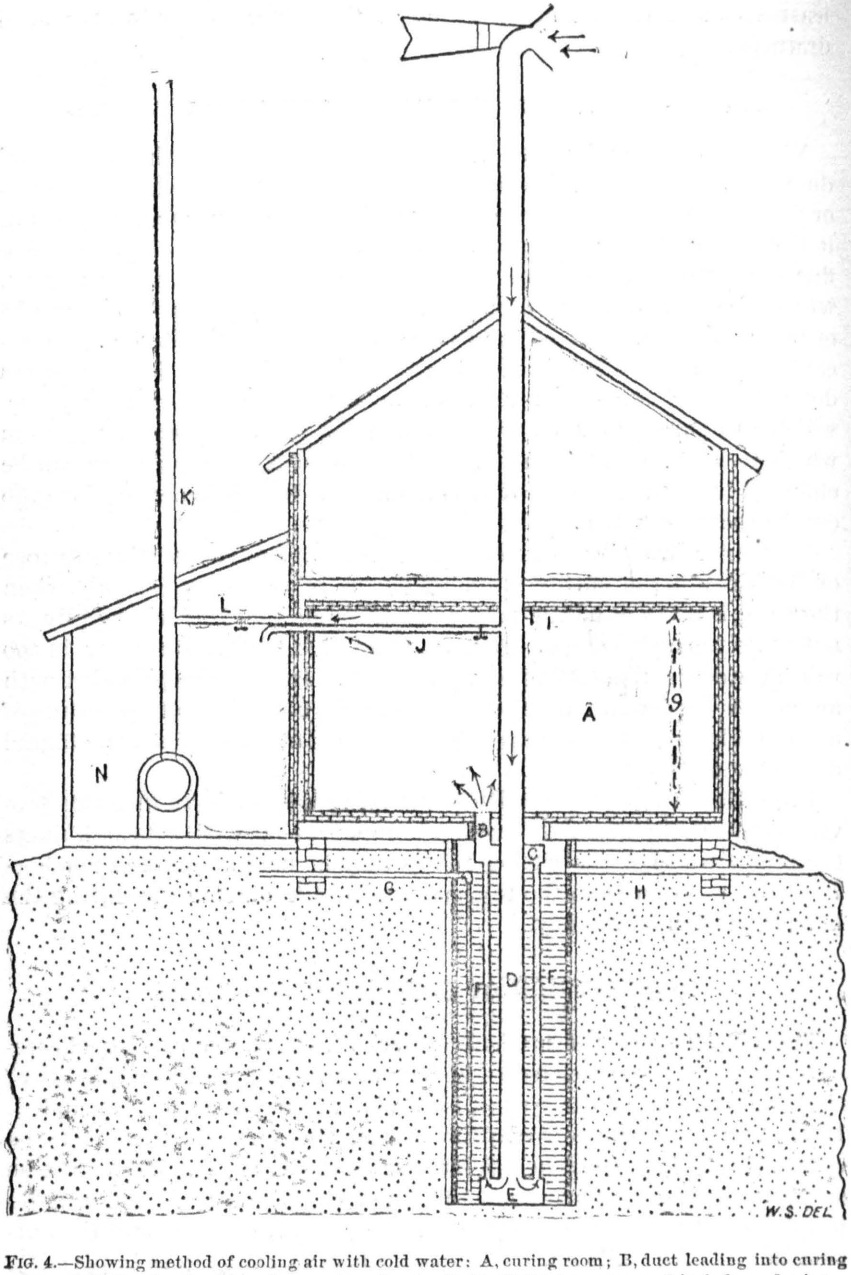


FIG. 4.—Showing method of cooling air with cold water: A, curing room; B, duct leading into curing room; C, E, galvanized iron drums, air and water tight; F, thirteen or more 5-inch flues of galvanized iron, 10 feet long, soldered water-tight to drums to cool air; D, main air duct from funnel; G, water pipe from pump; H, overflow pipe; I, damper in main shaft; J, 4 inch pipe leading from blower to use when there is no wind; K, smoke stack of boiler; L, ventilator from curing room to smoke stack; N, boiler.

curing room is to prevent the entrance of any air except through the subearth duct, or by an opening especially provided to be used only when the air from the duct is too cold or too damp.

In the bulletin of the Wisconsin Station noted above, Professor King gives detailed directions for the proper construction of curing rooms of wood and masonry.

WOODEN ABOVE-GROUND CURING ROOM.

The wooden structure is considered best for a curing room entirely above ground. The room is best located on the north side of the building, away from the direct rays of the sun, and the windows and door should fit closely and be built and closed on the refrigerator plan, if practicable. The walls should be constructed on the principle of cold-storage and icehouse buildings. They should be sheathed on the outside of the studding with matched sheathing and drop siding, with a layer of three-ply acid-proof and waterproof paper between, and on the inside with at least two layers of matched sheathing, with a layer of the three-ply paper between. A still better construction is to leave a dead-air space inside the studding, and to fill in the space between the studding with sawdust or some similar material. The construction is shown in fig. 5. The ceiling and floor should also consist of two thicknesses of matched lumber, with a layer of three-ply acid-proof and waterproof paper between, great care being exercised to make the joints tight at the corners.

UNDERGROUND CURING ROOMS.

Where practicable, underground curing rooms may be built in which the temperature through the hot season can be maintained as low as 58° to 63° if desired. To utilize the ground temperature to best advantage, the curing room should be not less than 9 feet below the level of the ground, and 10 or 12 feet is considered better. The walls are best made of stone up to within 5 feet of the surface, above which a more nonconducting material or construction should be employed. This upper portion may be made of stone, brick, or hollow building tile, laid so as to give an air space. The inside finish should be carried up between the joists, so that when the ceiling is put on no open joints will be left. The floor should be of concrete, since the cooling effect is derived chiefly from the floor. This concrete should be laid with care, and the finishing coat should be smooth and hard so as to give a glossy surface which will be water tight and easy to clean. The ceiling should be made of wood in the same manner as described above for the wooden curing room.

In case the curing room occupies the bank end of the basement of the factory, it will be necessary to build the partition between it and the work room with the same care to exclude heat as if it were an outside wall wholly above ground. If the partition is of wood, the side next to the curing room should have two thicknesses of

tongued and grooved flooring with a layer of paper between, and the door should be double and closed and fastened on the refrigerator plan. Windows should also be double and very close fitting, and if light enough can be secured from the north side, windows should only be placed here.

CENTRAL CHEESE-CURING ROOMS.

On account of the expense of constructing suitable curing rooms, with arrangements for holding the temperature within the danger limit, the Wisconsin Station has advocated central cooperative curing rooms

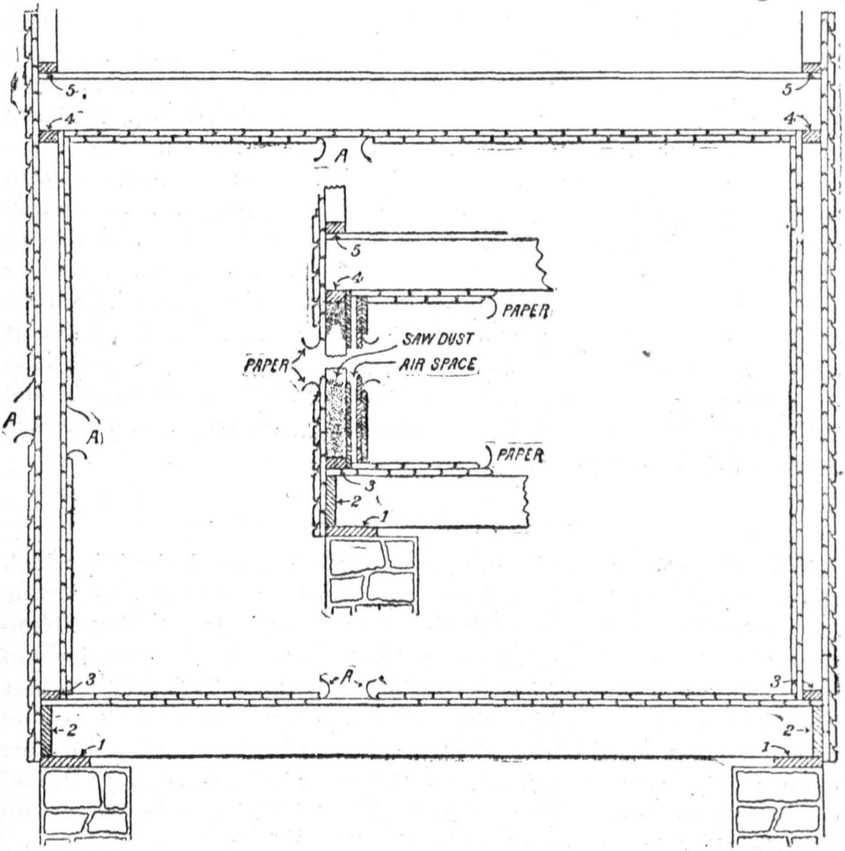


FIG. 5.—Showing the construction of wooden curing room: 1, 1, 1, sill; 2, 2, 2, a 2 by 10 plank spiked to ends of joist; 3, 3, 3, a 2 by 4 scantling spiked down after first layer of floor is laid to toe-nail studs to; 4, 4, 4, a 2 by 4 scantling spiked to upper ends of studding of first story; A, A, A, A, three-ply acid and waterproof paper. The drawing in the center shows space between studding filled with sawdust and another dead-air space to be used when the best ducts can not be provided.

or stations in regions where cheese factories are sufficiently thickly located. The cheese from a number of factories would be shipped to these central curing rooms at frequent intervals and ripened under safe and uniform conditions. Where a number of factories are operated under the same management this system would seem to be especially applicable. Aside from the improved quality of the product and the

higher price secured, the system would be more economical, being an extension of the cooperative plan, and would permit the employment of experts to cure and care for the cheese. Moreover, it would facilitate the sale of the product, making it possible for buyers to personally inspect large amounts of uniformly cured cheese; would reduce transportation charges, as large shipments could be made, and would enable the cheese makers to hold their product in cold storage without detriment until the conditions were favorable for selling.

IRRIGATION INVESTIGATIONS.

The appropriation act for the U. S. Department of Agriculture for the fiscal year ending June 30, 1899, made provision for the collection "from agricultural colleges, agricultural experiment stations, and other sources, including the employment of practical agents, of valuable information and data on the subject of irrigation, and publishing the same in bulletin form." Congress at its last session increased the appropriation for this work, authorizing the Secretary of Agriculture "to investigate and report upon the laws and institutions relating to irrigation and upon the use of irrigation waters, with special suggestions of better methods for the utilization of irrigation waters in agriculture than those in common use."

The Office of Experiment Stations, to which the work thus provided for was assigned by the Secretary of Agriculture, has, after consultation with experiment station officers and irrigation engineers familiar with the conditions of the irrigated region, undertaken to organize investigations in the following general lines: (1) The collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and (2) the publication of available information regarding the use of irrigation waters in agriculture as shown by actual experience of farmers and by experimental investigations. Elwood Mead, formerly State engineer of Wyoming, who has had a long and successful experience as irrigation engineer and administrator of irrigation laws, and is familiar with the agricultural conditions of the arid region, was given immediate direction of the work, with headquarters at Cheyenne, Wyo.

In recognition of the special facilities possessed by the experiment stations for investigations in irrigation as well as of the value of the work already done by some of them, the act of Congress above referred to authorizes and directs these institutions "to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories and as may be mutually agreed upon."

In pursuance of the plan of work adopted, the representative of the Department has made a study of the laws and institutions of a portion of the irrigated region, and the results thus far attained have been pub-

lished in two bulletins.[1] The first of these discusses the laws which control the diversion and use for irrigation of the waters of the Missouri River and its tributaries, embracing the States of Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming, and the Northwest Territories of Canada. The second bulletin gives abstracts of the laws for acquiring titles to water in the same region, with the legal forms in use.

No one can read these bulletins without realizing that the farmer from regions of ample rainfall who emigrates to the arid West has many things to learn besides how to build laterals and how and when to spread the water they carry over thirsty fields. The knowledge and skill required to distribute the water is soon acquired, but the working out of social and industrial institutions which will place the rivers, which govern the value of every farm they fertilize, under some form of public control which will secure their just distribution and prevent their becoming the subject of speculation or corporate monopoly is proving in the Western States, as it has in every irrigated land old enough to have a history, to be the enduring and important problem for farmers to solve, and the one on which the reward of their industry and the value of their farms ultimately depend.

The present situation in the States included in the discussion is thus set forth:

For every acre of irrigated land there has to be a right to water. The title to the latter is of as much importance as the deed to the land. It is much harder to establish. These rights take more forms than the rivers they control, and are acquired by as many methods as there are States to frame laws. In one respect they are alike: No matter whether the user of water derives his title direct from the State, buys it from a ditch company which furnishes water for hire, or from the holder of a speculative claim, it is a source of more perplexity at the outset, and of more hours of anxious thought afterwards, than all the other problems of irrigation combined. This is due in part to the fact that the ownership of streams is new and the nature of property rights therein uncertain; but, whatever the reason, the fact remains that the irrigator whose water right does not furnish grounds for either an inquiry or a grievance is a rare exception. Nor are irrigators alone in finding the limits of a water right hard to define or the problems of stream ownership hard to solve. Lawmakers and courts have both found them equally perplexing.

The reasons for this are not obscure. Because of uncertainty of what these rights should be, or difference of opinion on that question, the irrigation laws of many States have been made so ambiguous and contradictory that the finite intellect is not able to interpret their meaning. As a result there are laws and court decisions to sustain about every view of stream ownership of which the mind of man can conceive, and in some cases they are all found in the statutes and decisions of a single State. * * *

On many rivers there are now a multitude of claims to the common supply. These rights have to be defined in some way. If laws do not define them, then a resort to the courts is all that intervenes between the just claims of water users and anarchy. In many States the exigencies created by a failure to enact an administrative code have compelled the courts to become practically both the creators and enforcers of water laws. They have to devise a procedure for adjudications, supplement the

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[1] U. S. Dept. Agr., Office of Experiment Stations Buls. 58 and 60.

statute law in deciding what rights have been established, and finally have to protect irrigators' priorities by a liberal exercise of government by injunction. The growing volume of this litigation, the uncertain and contradictory character of many of the decisions, is making it a heavy burden to irrigators and a serious menace to progress. Unless it can in some way be restricted, it threatens to impair the value of investments in ditches and the success of this form of agriculture. In ten years the water-right litigation of one State is estimated to have cost over a million dollars. In many sections it has exceeded the money expended in constructing the ditches in which it has its origin. * * *

In considering the problems which these different State laws present, none seem more perplexing, nor in a larger aspect more illogical, than the change which occurs in the control and in the forms of ownership of a river when it crosses a State boundary. * * * So far as the productions or the needs of its farmers are concerned, there is no more reason for half a dozen water laws in the Missouri River watershed than there would be for that many different systems for acquiring titles to land. On the other hand, the complications which would grow out of a half dozen land systems are not to be compared to the complications which are being created by half a dozen different water laws, because these different titles to water and different methods of acquiring them all apply to a common supply.

Perhaps the most useful portion of the bulletins is the explanation of the several State laws and the description of the procedure which farmers have to follow in making and recording water-right filings. No one subject is a source of greater perplexity to the beginner than the establishment of a priority of right in the stream he diverts and nothing has caused greater hardship or loss than failure through lack of knowledge to conform to existing laws. The explanations of State systems are given in detail, so that the bulletins constitute a manual of forms as well as a discussion of principles.

In pursuance of the second line of work determined upon, extensive investigations on the duty of water, as measured by the actual amounts of water used by successful farmers on different soils in growing different crops, are being inaugurated with the cooperation of the experiment stations, irrigation engineers, and practical irrigators in different parts of the arid region. It is believed that these investigations will furnish the information regarding the quantity of water required to irrigate an acre of land, which is a necessity in every irrigated district in the making of water contracts, the planning of works, and the determination and protection of rights in streams, and without which all these important transactions have to be based largely on conjecture.

EXPLANATION OF TERMS.

TERMS USED IN DISCUSSING FERTILIZERS.

Complete fertilizer is one which contains the three essential fertilizing constituents, i. e., nitrogen, phosphoric acid, and potash.

Nitrogen exists in fertilizers in three distinct forms, viz, as organic matter, as ammonia, and as nitrates. It is the most expensive fertilizing ingredient.

Organic nitrogen is nitrogen in combination with other elements either as vegetable or animal matter. The more valuable sources are dried blood, dried meat, tankage, dried fish, and cotton-seed meal.

Ammonia is a compound of nitrogen more readily available to plants than organic nitrogen. The most common form is sulphate of ammonia, or ammonium sulphate. It is one of the first products that results from the decay of vegetable or animal substances.

Nitrates furnish the most readily available forms of nitrogen. The most common are nitrate of soda and nitrate of potash (saltpeter).

Phosphoric acid, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, rock phosphate, and phosphatic slag. Phosphoric acid occurs in fertilizers in three forms—soluble, reverted, and insoluble phosphoric acid.

Potash, as a constituent of fertilizers, exists in a number of forms, but chiefly as chlorid or muriate and as sulphate. All forms are freely soluble in water and are believed to be nearly, if not quite, equally available, but it has been found that the chlorids may injuriously affect the quality of tobacco, potatoes, and certain other crops. The chief sources of potash are the potash salts from Stassfurt, Germany—kainit, sylvinit, muriate of potash, sulphate of soda, and sulphate of potash and magnesia. Wood ashes and cotton-hull ashes are also sources of potash.

TERMS USED IN DISCUSSING FOODS AND FEEDING STUFFS.

Water is contained in all foods and feeding stuffs. The amount varies from 8 to 15 pounds per 100 pounds of such dry materials as hay, straw, or grain to 80 pounds in silage and 90 pounds in some roots.

Dry matter is the portion remaining after removing or excluding the water.

Ash is what is left when the combustible part of a feeding stuff is burned away. It consists chiefly of lime, magnesia, potash, soda, iron, chlorin, and carbonic, sulphuric, and phosphoric acids, and is used largely in making bones. Part of the ash constituents of the food is stored up in the animal's body; the rest is voided in the urine and manure.

Protein (nitrogenous matter) is the name of a group of substances containing nitrogen. Protein furnishes the materials for the lean flesh, blood, skin, muscles, tendons, nerves, hair, horns, wool, casein of milk, albumen of eggs, etc., and is one of the most important constituents of feeding stuffs.

Albuminoids is the name given to one of the most important groups of substances classed together under the general term protein. The albumen of eggs is a type of albuminoids.

Carbohydrates.—The nitrogen-free extract and fiber are often classed together under the name of carbohydrates. The carbohydrates form the largest part of all vegetable foods. They are either stored up as fat or burned in the body to produce heat and energy. The most common and important carbohydrates are sugar and starch.

Fiber, sometimes called crude cellulose, is the framework of plants, and is, as a rule, the most indigestible constituent of feeding stuffs. The coarse fodders, such as hay and straw, contain a much larger proportion of fiber than the grains, oil cakes, etc.

Nitrogen-free extract includes starch, sugar, gums, and the like, and forms an important part of all feeding stuffs, but especially of most grains.

Fat, or the materials dissolved from a feeding stuff by ether, is a substance of mixed character, and may include, besides real fats, wax, the green coloring matter of plants, etc. The fat of food is either stored up in the body as fat or burned, to furnish heat and energy.

MISCELLANEOUS TERMS.

Alkali soils.—Soils found in arid or semiarid regions, which contain an unusual amount of soluble mineral salts (alkali), which effloresce or bloom out on the surface of the soil in the form of a powder or crust in dry weather following rains or irrigation. Two distinct classes of alkali are known: Black alkali, composed largely of carbonate of soda, which is highly corrosive and destructive to vegetation; and white alkali, the characteristic constituent of which is sodium sulphate, and which is much less injurious than black alkali.

Duty of water.—As applied in irrigation this term means the area which a definite volume of a continuous flow of water will irrigate. The duty of a cubic foot per second may be taken as the number of acres of land which a continuous discharge of that volume during the growing season will irrigate.

FARMERS' BULLETINS.

These bulletins are sent free of charge to any address upon application to the Secretary of Agriculture, Washington, D. C. Only the following are available for distribution:

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No. 18. Forage Plants for the South. Pp. 30.
No. 19. Important Insecticides: Directions for Their Preparation and Use. Pp. 20.
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